New records and rare invertebrate specimens recorded during a decade of forest biodiversity research in Ireland

ARTICLE

***Rebecca Martin*[1]**
***Anne Oxbrough*[2]**
***Tom Gittings*[1]**
***Thomas C. Kelly*[1]**
***and John O'Halloran*[1]**

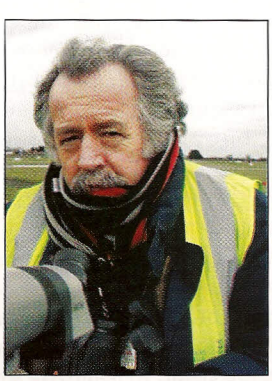
[1] PLANFORBIO, Department of Zoology, Ecology and Plant Science, University College Cork, Ireland; Corresponding author: r.martin@ucc.ie

[2] Department of Renewable Resources, University of Alberta, 751 General Services Building, Edmonton, Alberta, Canada T6G 2H1; anne.oxbrough@ales.ualberta.ca

Rebecca Martin

Anne Oxbrough

Tom Gittings



Thomas C. Kelly

John O'Halloran

Background

Ireland has been subject to extensive deforestation in the past two millennia, and only 1% of the country now consists of native or semi-natural woodlands (Forest Service, 2000a; Forest Service, 2000c). During the last century, approximately 10% of the land area was afforested, primarily through an increase in commercial plantations comprised of non-native conifers, particularly Sitka spruce (Joyce & O'Carroll, 2002). In addition, the Irish government aims to increase total forest cover to 14.5% by 2030, with this target mainly being met through plantation establishment. Traditionally, Irish forestry has been under the domain of the semi-state body Coillte, which planted extensively in upland areas. In more recent years there has been a policy shift with the government supporting private afforestation schemes on land more typically used for agriculture (Forest Service, 2007), whilst Coillte concentrates on harvesting and restocking its forests. Since 1998, Ireland has been committed to ensuring that all forestry development complies with the principles of Sustainable Forest Management (SFM), and as a result both new and restocked forests have been affected by changing policy aiming to create more diverse plantations (UNECE/FAO, 2003). This includes a suite of measures, from planting fewer monocultures and even-aged stands, to including more species of native provenance and leaving over-mature trees and deadwood *in situ* at the time of harvest (Forest Service, 2000a). Forests in Ireland are relatively small in size (on average 8-10 hectares), and

Two methods of collecting. Left: pitfall trap and right: canopy fogging.

are typically embedded in a landscape of intensive agriculture. In light of this and the low native woodland cover it is vital that the potential of plantations to support native flora and fauna is determined.

The importance of invertebrates to Irish forests

Invertebrates are an important component of forest biodiversity, inhabiting all areas from the soil and litter layers, to herb and under-storey layers, and the canopy. They have functional importance in food webs acting as herbivores, predators, as a food source for mammals and birds, and also as decomposers and pollinators (Buse & Good, 1993; Kevan, 1999; Barton *et al.*, 2009).

Until recently, few studies had focused on invertebrate diversity in Irish forests and little information was available on species typical of semi-natural woodlands, providing a baseline of the 'ideal' forest biota or on what fauna are supported in plantation forests. In the past ten years several large-scale research projects have been established to address some of these issues. The BIOFOREST project (2001-2006) examined over 100 sites across Ireland which included Sitka spruce and ash plantations at various stages of structural development, open habitats which are commonly used in afforestation (lowland bogs, heaths, managed grasslands etc.) and open space within mature plantations (Iremonger *et al.*, 2006a). At each site Araneae were sampled with pitfall traps, while Syrphidae were sampled with Malaise traps (Gittings *et al.*, 2005; Oxbrough *et al.*, 2005; Gittings, 2006; Gittings *et al.*, 2006; Oxbrough *et al.*, 2006a; Oxbrough *et al.*, 2006b; Oxbrough, 2007a; Oxbrough *et al.*, 2007b; Oxbrough *et al.*, 2010a). Additionally, data on ground vegetation and birds were collected (Wilson *et al.*, 2006).

The PLANFORBIO Research Programme (2007-2013) was initially conceived to in part follow on from the BIOFOREST project but has a much broader focus being comprised of four research projects: i) FORESTBIO which aims to examine the biota of Ireland's future forests including second rotation Sitka spruce and mixed species stands, but also obtain a 'baseline' of species in Ireland's native woodlands through extensive survey of oak and ash woodlands. Target taxa include ground-dwelling plants, canopy epiphytes, and a range of invertebrates and birds. Deadwood volumes have also been calculated (Sweeney *et al.*, 2010); ii) HEN HARRIER which uses radio tagging and nest cameras to examine this species' behaviour and habitat use in landscapes containing plantation forests (Wilson *et al.*, 2009); iii) RHODO which is investigating effective control measures for *Rhododendron ponticium* L.; and iv) BIOPLAN, which involves the implementation of an assessment and monitoring programme for biodiversity in Irish and Scottish forests. The overall aim of these projects is to form a set of management recommendations for improving biodiversity in plantation forests, by combining diversity data on a wide range of taxa from a variety of forest habitat types.

Invertebrate groups studied in detail on the BIOFOREST and FORESTBIO projects included Lepidoptera and Syrphidae, ground-dwelling Araneae and Carabidae, and canopy-dwelling Araneae, Coleoptera, and Opiliones, all of which were identified to species level. Methodologies employed included pitfall traps, Malaise traps, suction samplers, light traps and canopy fogging. The lack of previous invertebrate research in Ireland coupled with the geographically extensive and diverse range of sites sampled has led to a host of new records and rare specimens being recorded since 2001.

Rare species and new county records of Syrphidae:

Hoverflies (Diptera, Syrphidae) were sampled during BIOFOREST using Malaise traps. A total of 49,279 hoverflies of 112 species were identified, which represents 61% of the Irish hoverfly fauna. The majority of the species we recorded in mature spruce plantations were associated with open space habitats rather than closed-canopy forest (Gittings *et al.*, 2006).

One species new to Ireland was recorded: *Lapposyrphus lapponicus* (Zetterstedt, 1838) from a mature Sitka spruce plantation in Co. Kerry (Gittings, 2006). The project produced 134 new country records involving 64 different species, some of which were published (Gittings *et al.*, 2005; Speight & Gittings, 2006). Nine decreasing/threatened species were recorded (Table 1). These were mainly associated with three types of habitat features: conifer plantations, surface water habitat features and *Salix* scrub.

One of the most notable features of this survey was the general scarcity of conifer-associated syrphids (although two rare species were recorded; Table 1). There are eleven Irish species of syrphids with larvae that typically feed on aphids associated with conifer foliage (*Dasysrphus hilaris* (Zetterstedt), 1843, *D. pinastri* (DeGeer), 1776 *sensu* Doczkal (1996), *Didea alneti* (Fallen), 1817, *Eriozona syrphoides* (Fallen), 1817, *Lapposyrphus lapponicus, Megasyrphus erratic* (L.), 1758, *Melangyna compositarum* (Verrall), 1873, *Parasyrphus annulatus* (Zetterstedt), 1838, *P. lineolus* (Zetterstedt), 1843, *P. malinellus* (Collin), 1952 and *P. vittiger* (Zetterstedt), 1843) and some of these species have been quite widely recorded in Ireland (Speight, 2008a). However, only single records of three of these species were recorded during the BIOFOREST project (*L. lapponicus, M. erraticus* and *P. vittiger*). Therefore, it appears that commercial Sitka spruce plantations in Ireland are missing a habitat component that is required for these species, although what this habitat component is remains unknown.

By contrast with the conifer-foliage species, the one Irish saproxylic conifer-associated species (*Xylota jakutorum* Bagatshanova, 1980) was very widespread in the Sitka spruce plantations surveyed. It was recorded from 30 sites and was common or abundant in some sites. Prior to this survey, this species was regarded as infrequent in Ireland (Speight, 2000). It may be that the species has recently undergone a major increase in Ireland, coinciding with the maturing and harvesting of the major post-war established plantations. Another saproxylic species, *Sphegina clunipes* (Fallen), 1816, was also very common and wide-spread in the conifer plantations surveyed. This species was previously thought to be restricted to deciduous woodlands in Ireland (Speight, 2000) and its apparent habitat shift may also have been a response to the increased availability of suitable habitat in harvested plantations. Since completion of the BIOFOREST survey, another saproxylic conifer-associated species, *Sphegina sibirica* Stackelberg, 1953, has been recorded in Ireland for the first time in conifer plantations (Speight, 2008b).

Table 1. Records of decreasing/threatened Syrphidae, sampled using Malaise traps. Nomenclature follows Speight (Speight, 2008a).

County	Species Name	Year captured	Irish status[1]	Likely habitat source[2]
Kerry, Kilkenny	*Epistrophe nitidicollis* (Meigen), 1822	2004	Threatened/Decreasing	*Salix* swamp/conifer plantation
Kerry	*Lapposyrphus lapponicus* (Zetterstedt, 1838)	2003	Threatened	Conifer plantation
Kilkenny, Fermanagh, Tipperary	*Parasyrphus nigritarsis* (Zetterstedt), 1843	2002, 2004	Threatened/Decreasing	*Salix* swamp
Clare[3], Kerry	*Platycheirus amplus* Curran, 1927	2001, 2003	Threatened	Wet flushes in oligotrophic grassland
Carlow[3], Wicklow	*Xylota florum* (Fabricius), 1805	2001, 2003	Threatened	Unknown
Leitrim	*Meligramma guttta* (Fallen), 1817	3004	Decreasing	*Salix* swamp/*Fraxinus excelsior* treeline
Galway[3], Laois	*Orthonevra geniculata* (Meigen), 1830	2002, 2004	Decreasing	Acid fen and brook edge in *Salix* swamp
Kerry	*Orthonevra nobilis* (Fallen), 1817	2005	Decreasing	Acid fen
Kerry	*Parasyrphus vittiger* (Zetterstedt), 1843	2004	Decreasing	Conifer plantation

[1] Source: Speight (2008a)

[2] Based on habitat associations described by Speight (2008a) and the available habitats within the vicinity of the site

[3] Details of records published (Gittings *et al.*, 2005; Gittings, 2006)

Pure NS ground layer.

Rare species and new records of Araneae:

During the BIOFOREST project 65,063 adult spiders were identified from 219 species. This represents over half of the known Irish spider fauna. These were predominantly sampled from the ground layer (using pitfall traps) though some vegetation-dwelling species were collected using suction samplers and from the residue of Malaise traps (Oxbrough *et al.*, 2010a). The ground-dwelling spider fauna differ markedly between plantation forests and open habitats, with most rare species lost during the first five years after plantation establishment due to changes in vegetation cover and drainage and more generalist open species lost around the time of canopy closure (8-12 years) (Oxbrough *et al.*, 2005; Oxbrough *et al.*, 2006a; Oxbrough *et al.*, 2007b). Rare or notable ground-dwelling spiders were sampled predominantly from unplanted peatland habitats with fewer in the more intensively managed grasslands (Table 2). One new spider species record for Ireland *Meioneta mollis* (O.P. – Cambridge 1871) was collected in a blanket bog in the south west of Ireland (Oxbrough, 2007a).

In the plantation forests, the spider fauna was distinguished by both canopy species (conifer or broadleaf) and by structural development of the forest, which was primarily related to the amount of forest cover. There were no rare or notable species sampled in the closed canopy plantation forests, however there were over 20 species associated with forested or shaded habitats, some of which were found to be highly abundant including *Asthenargus paganus* (Simon, 1884), *Ceratinella scabrosa* (O.P. Cambridge, 1871) and *Lepthyphantes tenebricola* (Wider, 1834) (Oxbrough 2005).

A high number of new county records were found during BIOFOREST: 696 new records from 173 species (Oxbrough, 2007). This is due to both the large scale nature of this project (102 sites covering 21 counties) and the lack of previous research on Irish spiders, particularly those in forest plantations. For example, *Agyneta ramosa* (Jackson, 1912), has only recently been added to the Irish list (Fahy and Gormally 2003), but was sampled extensively in the more structurally developed plantations (434 individuals from 44 sites across 16 counties) whereas *L. tenebricola* had only been sampled previously in three Irish counties but was encountered commonly during BIOFOREST (723 individuals in 44 sites across 18 counties). Both of these species are known to be widespread across Britain (Oxbrough, 2007). Despite no rare species being sampled it is evident that a combination of both Sitka spruce and ash stands at various stages of structural development will enhance overall plantation biodiversity by supporting a diverse spider fauna. This is particularly important in Ireland where plantations are embedded in a landscape of intensively managed grassland (Oxbrough *et al.*, 2005; Oxbrough *et al.*, 2006a; Oxbrough *et al.*, 2007b).

Data of ground-dwelling spiders is currently being analysed from the native woodlands surveyed during the FORESTBIO project which is hoped will provide a baseline of expected species in Irish forests. Preliminary results suggest a different spider fauna between exotic conifer plantations and native woodlands and species sampled include *Pachygnatha listeri* (Sundevall 1830), which is associated with deciduous woodland habitats. This species was not sampled in over

Ash canopy.

Linyphiid spider, *Entelecara acuminata* (Top: male).

100 mature plantations across the island of Ireland during BIOFOREST and FORESTBIO but was found in three native woodlands which are scattered widely across Ireland.

Canopy-dwelling spiders were sampled from forests of coniferous and mixed plantations and native woodland dominated by oak or ash using thermal fogging during the FORESTBIO project. Thermal fogging disperses an aerosol insecticide into the tree canopy and invertebrates fall onto an arrangement of plastic sheets on the ground underneath where they are then collected. One new spider species record for Ireland was verified from FORESTBIO samples (Table 2) ; a Linyphiid spider, *Entelecara acuminata* (Wider 1834), which was captured using thermal fogging in a native oak woodland (WN1) (Martin, 2009).

Canopy spider species assemblages from native Irish ash and oak woodlands differed from those found in plantations, with *Clubiona brevipes*, *Araneus diadematus*, *Entelecara acuminata* and *Hahnia montana* being found exclusively in native woodlands, while *Porrhomma convexum* was found only in Sitka Spruce plantations and *Lepthyphantes obscurus* only in coniferous plantations of Sitka spruce, Norway spruce or a mixture of Norway spruce and Scots pine (Martin *et al.*, unpublished). These faunal differences may be related to differing microhabitat conditions between native woodlands and coniferous plantations such as leaf and branch structure and prey availability.

Rare species and new records of canopy-dwelling Coleoptera:

Canopy-dwelling Coleoptera were also collected using thermal fogging at the site types detailed above for the FORESTBIO project. Over 4000 specimens from 28 families and 106 species were identified. To date, one new species record for Ireland has been verified from the Anobiid beetle family, *Anobium inexspectatum* (Lohse 1954). *A. inexspectatum* is on the UK Red-list for Coleoptera (Table 3) and was found in the canopy of a native oak forest during the FORESTBIO project (Martin, unpublished). This species is known to be xylophagous on a variety of wood types, and is generally specific to deciduous woodlands in association with old *Hedera helix*. A number of the species in Table 3 are associated with specific woodland types: *Coeliodes transversealbofasciatus* is phytophagous on *Quercus* woodland, *Kyklioacalles roboris* is xylophagous and is found in deciduous and oak woodlands, *Malthodes guttifer* is predatory in deciduous and coniferous woodlands, *Mniophila muscorum* is phytophagous and is found in moss on a variety of trees, and *Orchesia minor* and *Tetratoma ancora* are mycetophagous and associated with fungus on deciduous trees. However, although all species in Table 3 were found in various woodland types, *Athous campyloides* and *Stenichnus poweri* are not woodland-associated species, and are more commonly found in open grassland habitats where *A. campyloides* is phytophagous and *S. poweri* is an active hunter (Buckland & Buckland, 2006).

Table 2: Araneae species identified to date from the BIOFOREST and FORESTBIO projects which occur in ≤5 Irish counties and are considered rare or notable in Britain. Nomenclature follows Roberts (Roberts, 1993).

County	Family	Species Name	Sampling Method	Year captured	British status (Harvey *et al.*, 2002)/New Irish Record**	Habitat Type Sampled	No. of Males/ Females
Clare, Galway	Linyphiidae	*Baryphyma gowerense* (Locket, 1965)	Pitfall trap	2002, 2004	Red Data Books - Insufficient data	Wet grassland, acid fen	4 Male: 1 Female
Donegal, Kerry, Mayo	Linyphiidae	*Satilatlas britenni* (Jackson, 1913)	Pitfall trap	2004	Nationally scarce in Britain – Notable B	Blanket bog	37 Male: 42 Female
Kerry	**Linyphiidae**	***Meioneta mollis* (O.P Cambridge 1871)**	**Pitfall trap**	**2004**	**New Irish Record****	**Blanket bog**	**19 Males**
Kerry	Dictynidae	*Nigma puella* (Simon, 1870)	Pitfall trap	2004	Nationally scarce in Britain – Notable A	Lowland blanket bog	1 Male
Kerry	Gnaphosidae	*Zelotes lutetianus* (L. Koch, 1866)	Pitfall trap	2004	Nationally scarce in Britain – Notable B	Lowland blanket bog	1 Male
Kilkenny	**Linyphiidae**	***Entelecara acuminata* (Wider, 1834)**	**Canopy fogging**	**2008**	**New Irish Record****	**Native oak woodland**	**1 Male: 1 Female**
Limerick, Tipperary	Linyphiidae	*Saloca diceros* (O.P.-Cambridge, 1871)	Pitfall trap	2002, 2004	Nationally scarce in Britain – Notable B	Wet grassland	6 Male
Mayo	Linyphiidae	*Maro sublestus* (Falconer, 1915)	Pitfall trap	2004	Nationally scarce in Britain – Notable A	Blanket bog	2 Male

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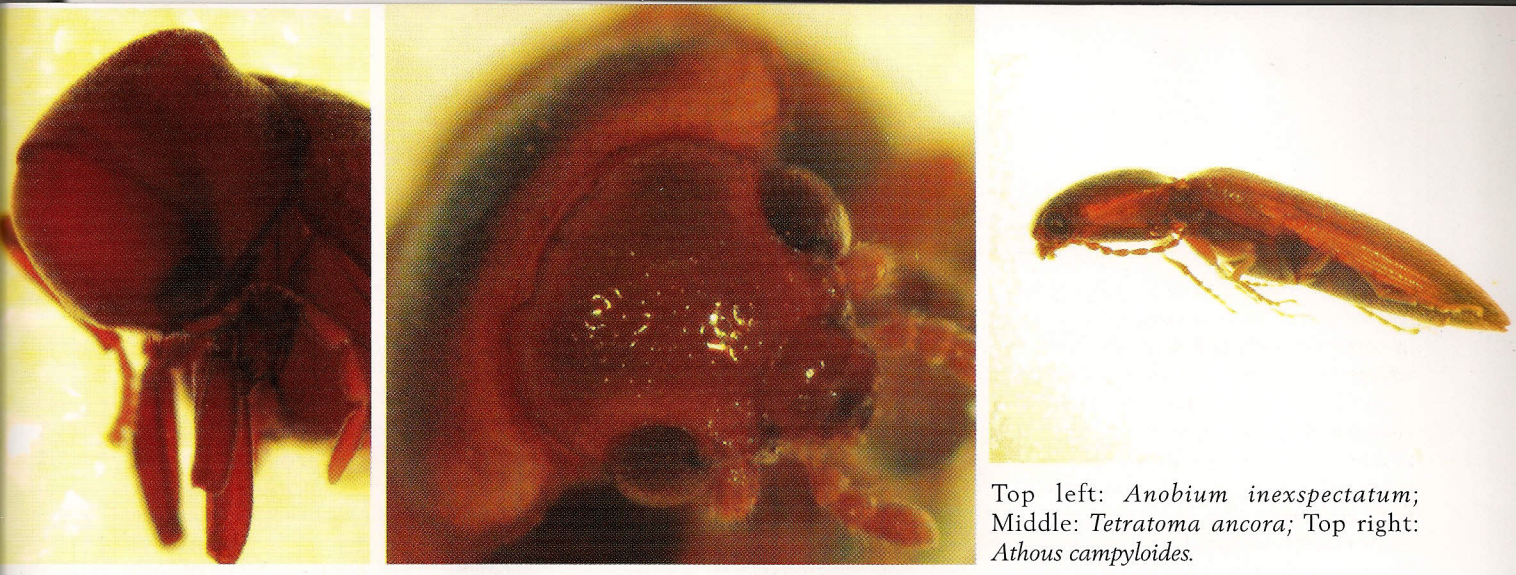
Malthodes mating.



Top left: *Anobium inexspectatum;* Middle: *Tetratoma ancora;* Top right: *Athous campyloides.*

Table 3. Details of Coleoptera sampled with canopy fogging during the FORESTBIO project. Nomenclature and Red-List status follows Bugs Coleopteran Ecology Package (Buckland & Buckland, 2006).

County	Family	Species Name	Year captured	Status (Buckland & Buckland, 2006)	Forest Canopy Type Sampled (Fossitt, 2000)	No. of specimens
Cork, Galway	Anobiidae	*Anobium inexspectatum* Lohse	2008, 2009	**New Irish record Nationally scarce in Britain - Notable B	Native oak woodland	4
Clare, Cork, Laois, Leitrim, Offaly, Tipperary	Elateridae	*Athous campyloides* Newman	2008, 2009	Nationally scarce in Britain – Notable B	Native Ash woodland, pure Norway spruce plantation, Norway spruce: Oak mixed plantation, Sitka spruce plantation	29
Cork	Curculionidae	*Coeliodes transversealbofasciatus* (Goeze)	2009	Nationally scarce in Britain – Notable B	Native oak woodland	1
Kilkenny, Tipperary, Wicklow	Curculionidae	*Kyklioacalles roboris* Curtis	2008, 2009	Nationally scarce in Britain – Notable B	Native oak woodland, native ash woodland	7
Antrim, Cork, Fermanagh, Galway, Roscommon	Cantharidae	*Malthodes guttifer* Kies.	2008, 2009	Nationally scarce in Britain – Notable B	Native ash woodland, native oak woodland, Sitka spruce plantation	54
Antrim	Chrysomelidae	*Mniophila muscorum* (Koch)	2008, 2009	Nationally scarce in Britain – Notable B	Native oak woodland	2
Donegal, Fermanagh, Leitrim, Roscommon, Tipperary	Melandryidae	*Orchesia minor* Walker	2008, 2009	Nationally scarce in Britain – Notable B	Native ash woodland, Norway spruce: Scots pine mix plantation	16
Cork, Offaly	Scydmaenidae	*Stenichnus poweri* (Fowler)	2008, 2009	Red Data Books - insufficient data	Native Oak woodland, pure Norway spruce plantation	2
Roscommon	Tetratomidae	*Tetratoma ancora* F.	2008, 2009	Nationally scarce in Britain – Notable B	Native ash woodland	3

Red-listed status is taken from the UK Red-list as detailed records of many Coleopteran species distributions and rarity are still relatively unknown in Ireland (www.jncc.gov.uk, 2010). Identification of voucher specimens was confirmed by Dr. Tom Gittings, University College Cork, Dr. Stephen Mc Cormack, Co. Waterford, Ireland and Dr. Roy Anderson, Belfast, N. Ireland. Voucher specimens have been deposited in the Museum in the Department of Zoology Ecology and Plant Science, University College Cork, Ireland.

Conclusions

Plantation forests have an important role to play in maintaining biodiversity in countries such as Ireland and Britain where landscapes are dominated by agriculture and cover of natural woodland is low. However further research is needed to assess their potential to support a diverse array of flora and fauna. For invertebrates, the importance of small scale habitat features within a stand such as litter layers and ground vegetation needs to be examined. In particular priority should be given to specialist groups, which are integral to ecosystem function. For instance, the role of saproxylic species in plantation forests in comparison with that in native woodlands is an area of research which is recognised internationally (Jonsell *et al.*, 2007; Richardson *et al.*, 2009). Deadwood volumes quantified during the FORESTBIO project indicates that Irish forests (both plantation and native) are lacking the large diameter logs and snags characteristic of high biodiversity old-growth forests, but the effect of this on saproxylic floral and faunal biodiversity has yet to be quantified. However, it is clear that management practices need to be modified so that deadwood volumes can be increased in both plantation forests and native woodlands (Sweeney *et al.*, 2010).

The extensive research in Ireland carried out in recent years is in stark contrast to that of previous times, which is exemplified by the new Irish Araneae and Syrphidae species record and new Irish county records of Araneae and Syrphidae from the BIOFOREST project, as well as new Irish Araneae and Coleopteran species records, and the large number of rare Coleopteran species from the FORESTBIO project. Canopy fogging samples collected during FORESTBIO, including, for example, the Hemiptera, Hymenoptera and Diptera and the Lepidoptera species data are currently being analysed, and analysis of biodiversity indicators and habitat associations for all other taxa sampled during FORESTBIO are underway. Results of these analyses will directly contribute to the management policies of Irish planted and native forests so that biodiversity in these habitats can be optimised. This has led to a build-up of taxonomic expertise and has laid the foundations for continuing work on Irish forest research and the improvement of biodiversity and forest management practices.

With historical forest cover being reduced to <1% around the last century, many forest species may have been lost, thus a key element to forest biodiversity research is finding out what the 'true' flora and fauna of Irish woodlands is and whether it is particularly specialised. Research carried out on the Forestbio project examining the invertebrate fauna of native woodlands aims to begin to examine some of these issues.

See http://BIOFOREST.ucc.ie/ for more information on the BIOFOREST project including final technical reports (funded by the EPA and COFORD under the National Development Plan 2001-2006). See http://www.ucc.ie/en/planforbio/Projects/FORESTBIO/ for more details on the FORESTBIO project (funded by COFORD and IRCSET under the National Development Plan 2007-2013).

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